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Monitoring heavy metal concentrations in the sediments of the Moskva and Oka River system- Results of the Volga-Rhine-Project

Höpke Andresen
Heidelberg, Instiute of Earth Sciences, Heidelberg, Germany (hoepke.andresen@geow.uni-heidelberg.de)

In the course of the Volga-Rhine-Project sediment, water and pore water samples were collected on the Volga as well as the Moskva and Oka river systems. The sampling area discussed here is located south east of the city of Moscow. Sediment samples were taken along the Moskva River between Moscow and the city of Kolomna, which is approximately 100 km to the southeast of Moscow and in the Oka River close to the confluence with the Moskva River (Kolomna). The first sampling campaign in this region took place in 1993, followed by further sampling in 1997 and 2007.

For evaluation of sediment quality classification systems are often used. The geo-accumulation index proposed by Mueller (1979) is a classification system which consists of seven classes given by the following expression:

$$I_{geo} = \frac{\log_2 \cdot C_n}{1.5 \cdot B_n}$$

Where C_n = measured concentration; B_n = background value (Turekian & Wedepol 1961) of element n and 1.5 = background matrix correction factor. The geo-accumulation index consists of seven grades (0-6) which indicate the enrichment of an element compared to the background value. These grades range from "not polluted" to "very strongly polluted". Another possibility to express sediment contamination is to evaluate the effects on the ecosystem. The lowest effect level (LEL) gives the concentrations of the heavy metals in sediment below which no effect on the majority of the sediment dwelling organisms is expected. The probable effect level (PEL) represents the concentration of heavy metals above which the organisms frequently will show adverse effects.

Both of these approaches were used to evaluate the results of the Volga-Rhine-Project. In the last two decades the concentrations of heavy metals in the sediments decreased by up to 60%. In 1993 sediments revealed high concentrations of several heavy metals such as chromium, cadmium, lead, zinc, arsenic, nickel and cobalt, whereas in 2007 only two sediment samples were classified as "very strongly polluted" regarding lead and cadmium concentrations. Additionally six other sediment samples were found to be "strongly polluted" with cadmium, zinc and lead, respectively. Using the ecotoxicological approach on the sediments, chromium, cadmium and zinc are above the PEL, whereas the content of lead exceeds the LEL. Thus, these metals may still cause toxic effects on the fresh water system.

Although the input of heavy metals into the river systems has clearly decreased during the last 20 years, there are still some locations where high concentrations of heavy metals are found, suggesting point sources. Especially cadmium still shows significantly higher concentrations than the background value in the entire sampling area. There are even two sampling points where the cadmium concentrations reach approximately 100x the background value. To determine the temporal variation of the heavy metal input, sediment cores were taken. Heavy metal concentrations increase with depth in the cores and show a maximum at a depth of about 35-40 cm. Some part of this increase may be a result of early diagenesis as well as a result of reduced heavy metal input. The nature of the decline of the heavy metal concentrations is still in progress.

Despite all the improvements achieved in environmental protection in Russia, still some problems have to be addressed. Especially in urban areas like the Moscow region the number and the size of illegal dump sites is increasing dramatically, leading to strong inputs of heavy metals and other pollutants into the river systems, with consequences for the sensitive eco systems.